A REPORT

ON

INVESTIGATION

OF

THE DISEASE BEARING MOSQUITO HAZARD IN CALIFORNIA

SUBMITTED TO THE GOVERNOR AND TO THE FIFTY-SIXTH SESSION OF THE CALIFORNIA LEGISLATURE PURSUANT TO SENATE CONCURRENT RESOLUTION No. 11 BY THE STATE DEPARTMENT OF PUBLIC HEALTH

JANUARY 1945

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California

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC HEALTH
SAN FRANCISCO (2), CALIFORNIA, January 19, 1945

His Excellency The Governor of California
and *The California Legislature*
State Capitol
Sacramento, California

GENTLEMEN: Pursuant to Senate Concurrent Resolution No. 11, we are submitting a copy of our Report and Recommendations on the Disease Bearing Mosquito Hazard in California.

Sincerely,

WILTON L. HALVERSON, M.D.
Director of Public Health

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REPORT ON INVESTIGATION OF THE DISEASE BEARING MOSQUITO HAZARD IN CALIFORNIA

Prepared by the State Department of Public Health in Accordance With Senate Concurrent Resolution No. 11

SUMMARY AND RECOMMENDATIONS

Summary

Malaria

(1) Malaria in California is now being reasonably well controlled by the combined efforts of the local mosquito abatement districts and the wartime activities of the United States Public Health Service, through the State Department of Public Health.

(2) The effect of the return of large numbers of malaria carriers from combat areas can not be accurately assessed. Plans must be made to meet this problem.

(3) The Malaria Control Program of the United States Public Health Service around military establishments employs 35 to 40 men with completely equipped trucks and includes two mobile units immediately available in the event of a malaria outbreak anywhere in the State.

(4) Existing Mosquito Control Programs should be maintained and expanded to assist in control of other mosquito-borne diseases.

Other Mosquito-borne Diseases

(5) Other mosquito-borne diseases, including yellow fever, dengue fever, filariasis and encephalitis, might be imported but only the last is considered a public health problem in California.

(6) Both the St. Louis and Western equine types of encephalitis have been known to exist in California for many years and have been recently demonstrated as transmissible by common domestic mosquitoes.

(7) The reported deaths from encephalitis for the past 10 years have averaged 45 per year as compared with five per year for malaria.

(8) Japanese "B" and other types of encephalitis may be imported into California, and if not recognized and promptly controlled, the results might well become catastrophic; for example, the 1924 Tokyo epidemic caused 6,000 cases and 3,797 deaths.

(9) Advance of battle areas toward Japan and Eastern Asia will expose our military personnel to Japanese "B" encephalitis, and with rapid air transport unrecognized cases could easily reach California.

(10) The only practical method for control of our present encephalitis and Japanese "B" encephalitis is mosquito control, since effective vaccines or chemical prophylactics are not available for humans.

(11) The highest incidence of encephalitis as well as malaria in California is reported from the great Central Valley and the State should develop a Mosquito Control Program for counties in that area.

(12) Since equine encephalomyelitis (horse brain fever) is also transmitted by mosquitoes, a control program would be advantageous for economic as well as public health reasons.

(13) A plan is needed for quick assembly of State and local health and mosquito control agencies for work in any area affected by imported mosquito-borne disease such as malaria and Japanese "B" encephalitis.

MOSQUITO CONTROL

(14) The long established techniques of mosquito control must still be used since recently reported advances including the use of D.D.T. (Dichloro-diphenyl-trichloroethane) were developed for military purposes and are not yet available for civilian use.

(15) Present mosquito control work in organized districts is limited to 3 per cent of the area of the State and within the districts fairly good control of pest mosquitoes is accomplished with an expenditure of $363,000 annually.

(16) Wartime malaria and mosquito control in the immediate vicinity of military establishments is effective with an expenditure of $67,000 annually.

(17) In other areas of the State, except a few in which local health departments carry on relatively small local programs, no mosquito control work is done.

(18) A State-wide and State-operated program designed to control pest as well as disease bearing mosquitoes, is not considered feasible, and the results obtained would not justify the cost which is estimated to be between $5,000,000 and $10,000,000 per year.

(19) A State-operated Mosquito Control Program, limited to areas having the highest incidence of mosquito-borne disease, would not be desirable, particularly in those sections now carrying on local control work, because it would be difficult to avoid parallel organizations, overlapping jurisdiction, and other vexatious problems. The cost is estimated at $850,000 per year.

(20) A Program of Mosquito Control, supervised by the State, with subventions to local governmental agencies meeting minimum standards of personnel and operations, limited to areas having the highest incidence of mosquito-borne disease, and with two mobile units for State-wide use is considered most desirable. Effective operation would require the expenditure of approximately $500,000 per annum.

(21) A program of State promotion of local districts with technical field staff and mobile demonstration units would possibly accomplish good results if enough time were allowed. This would be less effective than a program including subventions. The cost would be about $75,000 per annum.

(22) Formation of mosquito abatement districts under the existing act and with the restrictions of the District Investigations Act of 1933 is extremely difficult and cumbersome and causes delay in working out any program. This should be remedied, by amendments to both the Mosquito Abatement Chapter of the Health and Safety Code and the District Investigations Act of 1933.

Recommendations

It is recommended that:

(1) A Program of Mosquito Abatement be planned and developed for all sections of the State now having mosquito-borne disease problems.

(2) Subventions be made to local agencies meeting minimum standards for personnel and operation on an equal matching basis.

(3) A sum of $500,000 per year be made available to carry out this project including the following items:

	First Year	*Second Year*
Training Program	$12,000 00	----------
Administration	50,000 00	50,000 00
Equipment for Mobile Units	8,000 00	1,600 00
Field Personnel	15,000 00	15,000 00
Materials and Supplies	2,000 00	2,000 00
Transportation	2,000 00	2,000 00
Travel Expense	8,000 00	8,000 00
Contingencies	3,000 00	3,000 00
Subventions to Local Agencies	400,000 00	418,400 00
	$500,000 00	$500,000 00

(4) A plan be developed for quick assembly of State and local health and mosquito abatement agencies for work in any area affected by imported mosquito-borne disease such as malaria and Japanese "B" encephalitis.

(5) The Mosquito Abatement Chapter of the Health and Safety Code be amended to provide a procedure for initiation of formation proceedings by resolution of the county board of supervisors.

(6) The District Investigations Act of 1933 be amended to provide that it does not apply to mosquito abatement districts.

REPORT

Introduction

This report is prepared in accordance with Senate Concurrent Resolution No. 11, adopted in the Senate June 12, 1944, and in the Assembly June 13, 1944. The resolution reads as follows:

Senate Concurrent Resolution No. 11—Relating to the investigation of the malaria hazard in California.

WHEREAS, Records show that malaria has been endemic in California since the earliest settlers arrived; and

WHEREAS, Anopheline mosquitoes, which are the vector of malaria, are widespread in the State, being especially prevalent in the irrigated areas of the great Central Valley; and

WHEREAS, The State Department of Public Health and the University of California started the control of malaria and of Anopheline mosquitoes more than 30 years ago and have continued to foster the development of mosquito control through local agencies, particular mosquito abatement districts under an act of the Legislature in the year 1915, all of which has resulted in a marked control of malaria in peacetime; and

WHEREAS, The returned of the armed forces from tropical theaters of war is and will continue to be a threat to the public health of the people of California, because of the high incidence of malaria infection among discharged personnel and convalescents on furlough; and

WHEREAS, The normal measures for the control of malaria may become insufficient under war or postwar conditions; now, therefore, be it

Resolved, by the Senate of the State of California, the Assembly thereof concurring, That the Director of the State Department of Public Health is hereby respectfully urged to consider existing and alternative methods of mosquito control and abatement, including an evaluation of the comparative effectiveness, feasibility and cost of each such alternative method and to submit a report and his recommendations to the Governor and to the Legislature not later than the Fifteenth Legislative Day of the Fifty-seventh Regular Session of the Legislature; and be it further

Resolved, That the Secretary of the Senate is hereby directed to forward a copy of this resolution to the Director of the State Department of Public Health.

This report is concerned with the threat to the public health of the people of California from mosquito-borne diseases now existing in the State and those which may be introduced hereby returning military personnel. The discussion of disease hazards will, therefore, be divided into two parts, the first dealing with malaria and the second with all other mosquito-borne diseases which have been or may be introduced into California. Time has not permitted a detailed study of "existing and alternative methods of mosquito control and abatement," but from department records and conferences with local officials, sufficient data have been obtained to make this report.

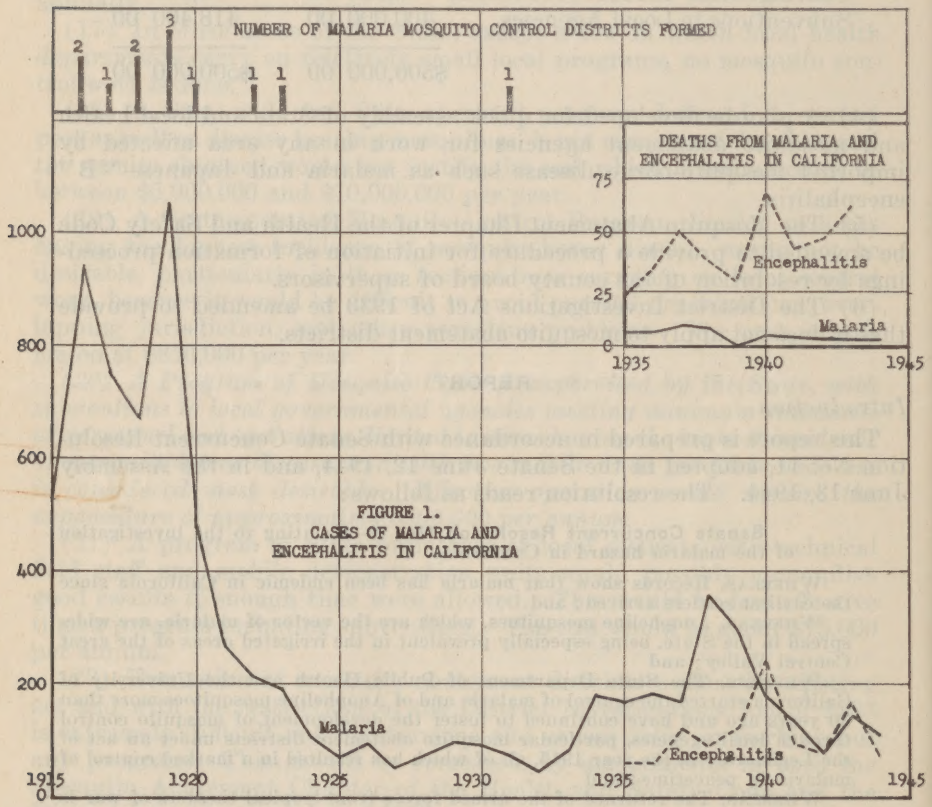

FIGURE 1.
CASES OF MALARIA AND
ENCEPHALITIS IN CALIFORNIA

Malaria

Malaria is the best known mosquito-borne disease, and annually affects over 20,000,000 people throughout the world. The malarious areas are widespread within the Tropic and Temperate Zones. The theaters of war in the Pacific are all located in highly endemic areas. In the early days of the war, malaria in these areas caused more casualties than those from actual battle, and practically every military person was affected with the disease. The Army and Navy, in order to make their military efforts effective, have instituted anti-malarial campaigns including mosquito control, thus reducing the incidence of malaria among certain

overseas military units from approximately 960 per 1,000 to 40 per 1,000. This reduction is important as the number of potential malaria carriers returning to this State has been greatly reduced.

This history of malaria in California clearly indicates that the control of mosquito breeding, a general improvement of irrigation practices in

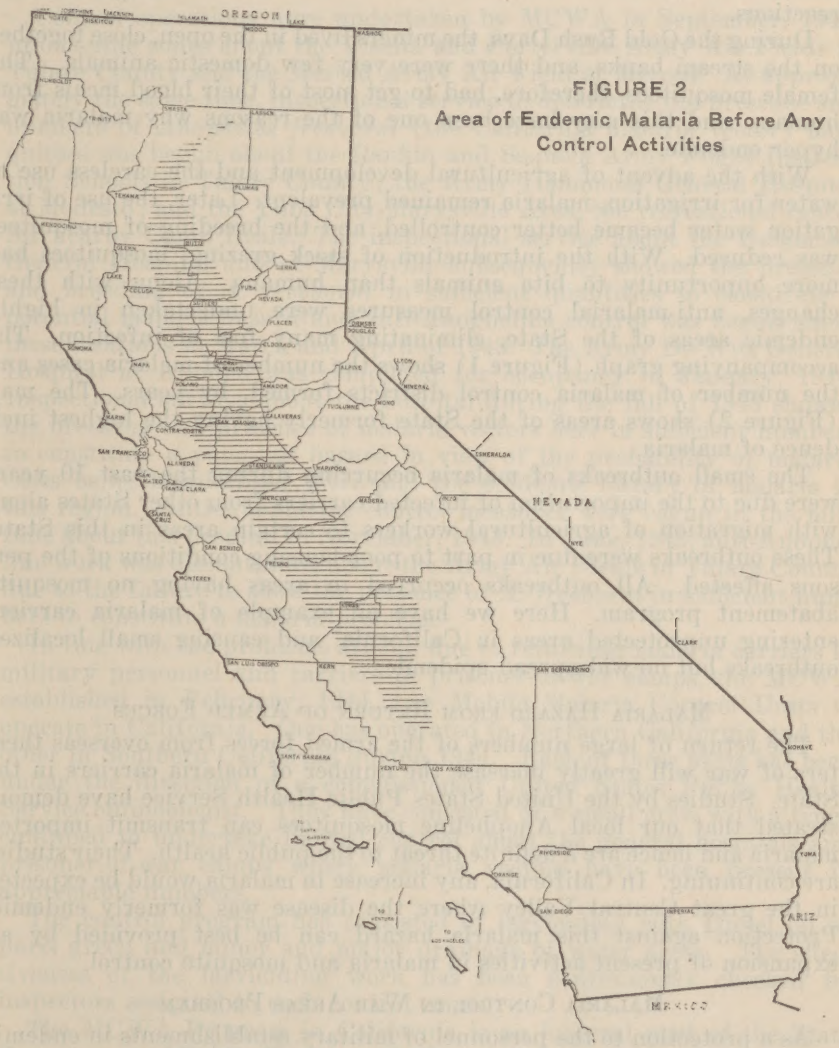

FIGURE 2
Area of Endemic Malaria Before Any Control Activities

the use of water, and improvement in housing conditions of the people have reduced the importance of this disease locally, thus eliminating the important foci of infection. To justly appreciate the effect of this change in the malaria history, it is wise to consider the habits of the malaria-

carrying mosquito *(Anopheles freeborni)* in California. The female of this species, before it can lay its eggs, must have a blood meal, and obtains it by biting an animal or human. As a result of this biting habit, malaria is transmitted from one human to another. Recent extensive laboratory studies have shown that about 4 per cent of the mosquitoes with blood meals have ingested human blood, 60 per cent have ingested bovine blood, and the remainder had blood from other animals, or gave indefinite reactions.

During the Gold Rush Days, the miners lived in the open, close together on the stream banks, and there were very few domestic animals. The female mosquitoes, therefore, had to get most of their blood meals from humans, and this may have been one of the reasons why malaria was hyper endemic.

With the advent of agricultural development and the careless use of water for irrigation, malaria remained prevalent. Later, the use of irrigation water became better controlled, and the breeding of mosquitoes was reduced. With the introduction of stock grazing, mosquitoes had more opportunity to bite animals than humans. Along with these changes, anti-malarial control measures were undertaken in highly endemic areas of the State, eliminating many foci of infection. The accompanying graph (Figure 1) shows the number of malaria cases and the number of malaria control districts formed, by years. The map (Figure 2) shows areas of the State formerly having the highest incidence of malaria.

The small outbreaks of malaria occurring during the past 10 years were due to the importation of infected carriers from other States along with migration of agricultural workers to certain areas in this State. These outbreaks were due in part to poor housing conditions of the persons affected. All outbreaks occurred in areas having no mosquito abatement program. Here we have an example of malaria carriers entering unprotected areas in California, and causing small localized outbreaks but no widespread epidemic.

Malaria Hazard from Return of Armed Forces

The return of large numbers of the armed forces from overseas theaters of war will greatly increase the number of malaria carriers in the State. Studies by the United States Public Health Service have demonstrated that our local Anopheline mosquitoes can transmit imported malaria and hence are a definite threat to the public health. Their studies are continuing. In California, any increase in malaria would be expected in the great Central Valley where the disease was formerly endemic. Protection against this malaria hazard can be best provided by an expansion of present activities in malaria and mosquito control.

Malaria Control in War Areas Program

As a protection to the personnel of military establishments in endemic malaria areas, the United States Public Health Service, under the direction of the State Department of Public Health and in co-operation with the Army and Navy, has undertaken active anti-malarial control programs around these establishments. The program is known as Malaria Control in War Areas (MCWA).

The control of Anopheline or malaria-bearing mosquitoes is confined to malarious areas contiguous to military establishments, areas where

large numbers of military personnel congregate, and areas adjacent to essential war industries or essential war housing.

Operations of Malaria Control in War Areas in California were first undertaken in August, 1942, when the State Office was organized in the Bureau of Sanitary Engineering, after an intensive survey of war areas was instituted to determine where active malaria control operations should begin.

Control operations were undertaken by MCWA in September, 1942, in one-mile zones about the Visalia and Porterville Army Air Fields in Tulare County and the Merced Army Air Field at Merced. At approximately the same time, inspectional service to determine the presence and numbers of *Anopheles freeborni* (the California malaria vector) mosquitoes was begun about the Rankin and Sequoia Army Flight Instruction Schools in Tulare County; the Army Hammond General Hospital at Modesto; and the Yuba City-Marysville Area, the recreational center for nearby Camp Beale. The inspectional service about the Hammond General Hospital and at Marysville subsequently showed the presence and breeding of *A. freeborni* in sufficient quantities to constitute a potential malaria hazard and anti-Anopheline control was begun about these locations in March and April of 1943. The Army De Witt General Hospital at Auburn was completed for occupancy in January, 1944. Inspectional surveys about the hospital during the fall of 1943 showed the breeding and presence of malaria vectors here in sufficient numbers to constitute a potential hazard in view of the probability of malaria cases being hospitalized there and the epidemic history of malaria in this region. Anti-Anopheline control measures were begun in the mile zone about this hospital in November, 1943. In June, 1943, anti-Anopheline work was discontinued about the Army Air Fields in Tulare County due to the failure to show the presence of *A. freeborni* in sufficient numbers to constitute a malaria problem.

In line with the problems arising due to returning malaria carriers in military personnel and carriers in prisoner-of-war camps, the MCWA established in February, 1944, two Mobile Malaria Control Units to operate in California. One has operated in Northern California and the other in Southern California during 1944. Each of these units has been under the direction of a commissioned United States Public Health Service entomologist. They have consisted of a small crew with a truck equipped to undertake limited control about the general hospitals and prisoner-of-war camps where malaria vectors have been present in appreciable numbers.

The control program has consisted of larviciding with Diesel oil or paris green and minor and major drainage of water areas. The effectiveness of the larviciding work has been continuously checked by inspectors assigned to each control zone.

The MCWA Program in California is an integral part of the State Department of Public Health, and all work done by its men is in cooperation with the local health officers in each area in question. Six United States Public Health Service officers, three office workers, and a field crew of four area supervisors, four area inspectors, and a varying number of laborers, depending on the season, are employed on this program. Since the inauguration of the work, 42 military areas have been carefully sur-

veyed for the presence of *Anopheline freeborni*. Anopheline control procedures have been carried on in 17 of these war areas.

Other Mosquito-borne Diseases

In the present Pacific War Theater our Soldiers and Sailors are now being exposed to other mosquito-transmitted diseases, including yellow fever, dengue fever, filariasis and, as the Pacific Theater moves forward, our men will move into an area where Japanese "B" encephalitis is endemic and where many severe epidemics have occurred. Japanese "B" encephalitis is a type of insect-borne virus disease closely related to the Western equine type and the St. Louis type of encephalitis which have been recognized in California within the last 15 years. Other virus infections which might be introduced into California are the Eastern equine type and the Venezuelan type of encephalitis.

Yellow Fever and Dengue Fever

Although yellow fever and dengue fever are important in the Pacific Area, these two diseases are transmitted by mosquitoes not known to be present in California. Hence, it is assumed there is no threat to the public health of the people of California from these two diseases.

Filariasis

Filariasis which, as a result of repeated infections, develops into elephantiasis, has been the cause of many fears among our Service Men in the Pacific Area. Infected military people are hospitalized and returned to this Country immediately. Several common species of our ordinary so-called pest mosquitoes are capable of transmitting this disease. Thousands of these cases have been returned to this Country but as yet there is no knowledge of the transmission of the disease from these cases. The infective agent in this disease is a worm which develops in the lymph glands and the larvae of these worms enter the peripheral bloodstream and only when present there can this disease be transmitted by mosquitoes. Several thousand returned patients have been tested, but, in an exceedingly small number of cases have larval forms of the worm been found in the peripheral bloodstream. Filariasis cases are kept under careful observation by the Medical Departments of the Army and Navy and most of them are considered non-infective. Hence, filariasis brought to California by returning military personnel is not considered to be a public health threat.

Encephalitis

Studies carried out in the past few years indicate the method of spread and the animal hosts of Western equine and St. Louis types of encephalitis. Because of the great public health importance of these two diseases in California, they will be discussed in some detail.

The Western equine type was previously thought to affect only horses, but studies of recent outbreaks in the San Joaquin and Sacramento Valleys have shown that this disease also may be transmitted to man. In human cases, the early symptoms are familiar to poliomyelitis. Many investigators believe that about 25 per cent of the cases diagnosed as poliomyelitis are in reality cases of encephalitis.

Mosquitoes have been known for some time to be capable of transmitting the encephalitis viruses in the laboratory, but in 1943 it was demon-

strated for the first time in Kern County, California, that mosquitoes were infected in nature and those species found infected were capable of transmitting the disease. Mosquitoes were demonstrated repeatedly to be infected. At the same time it was demonstrated that domestic fowl and other birds are the common source of mosquito infection, although these birds show no evidence of infection. Extensive field and laboratory studies of these infections are being continued by research workers of the Hooper Foundation, University of California Medical School. Our knowledge at the present time definitely incriminates as vectors several species of the common so-called "pest" mosquitoes of California, particularly *Culex tarsalis*. *Culex pipiens*, *Aedes dorsalis*, *Culiseta inornata*, and *Anopheles freeborni* have all been found infected in nature. Most of these mosquitoes breed in greatest numbers in foul waters, such as cesspools, sewer farms, dairy barn, and farm drainage.

Although domestic and wild fowl, acting as a reservoir, are not affected by this disease, mosquitoes biting these fowl may transmit it to larger animals or human beings, causing equine encephalomyelitis in horses and encephalitis in humans. It has been definitely proved that the mosquitoes do not transmit the virus from one large animal to another or to a human but must pick up the virus from a fowl. The accompanying tables (Table I and Table II) show the number of human cases of encephalitis in California in recent years. The disease occurs in all sections of the State. The highest incidence has been reported in 16 counties of the Sacramento-San Joaquin Valleys, as shown on the map (Figure 3).

Equine Encephalomyelitis

Although not of public health importance, the loss of live stock is of economic importance and should be considered. For this reason, data relative to the incidence of cases of equine encephalomyelitis in California and the United States are given in the accompanying table (Table III). The economic loss to the State is considerable. Fortunately, a successful animal vaccine against this disease has been developed and since its use the number of animal cases has been reduced. It is important to note that human vaccines have not commonly been used.

Japanese "B" Encephalitis

In the study of encephalitis in California, the types found in other areas also have been studied. These studies brought out that the Japanese "B" encephalitis occurring in Japan and Eastern Asia, is caused by a virus similar in certain ways to the strains found in California. This disease is also transmitted by many species of mosquitoes, some of which are commonly found in California. With this virus the reservoir for the disease is the human carrier or large animal. On the eighth to tenth day after a person is bitten by an infectious mosquito, he carries the virus in his bloodstream and is a potential source of mosquito infection. He may or may not become ill. Prior to the advent of rapid transoceanic transportation, this disease would have been of no consequence, as the period during which the virus circulates would have been completed before the patient could arrive in this Country. With trans-Pacific crossings by airplane in a few days, it is possible for infected persons to enter this Country without the disease being recognized. With the presence of uncontrolled mosquitoes capable of transmitting this disease, a definite threat to public health of California people might

exist. Should this strain of encephalitis be introduced, the results might well become catastrophic. This disease has a high fatality rate. Its presence in Japan was reported as early as 1900. More than half the cases of the Tokyo epidemic of 1924 were fatal, 6,000 cases being reported, with 3,797 deaths.

Table I—Cases of Human Encephalitis Reported in California, 1935-1944, by Counties

County	*1935*	*1936*	*1937*	*1938*	*1939*	*1940*	*1941*	*1942*	*1943*	*1944*
Alameda	5	8	7	5	4	2	3	2	11	7
Alpine	--	--	--	--	--	--	--	--	--	--
Amador	--	--	--	--	--	--	--	--	--	--
Butte	—	2	—	1	2	2	2	—	5	—
Calaveras	--	--	--	--	--	--	--	--	--	2
Colusa	—	--	--	1	--	1	--	--	1	--
Contra Costa	4	3	—	1	1	1	2	1	4	3
Del Norte	--	--	--	--	--	--	1	--	--	--
El Dorado	--	--	--	--	1	--	--	--	--	--
Fresno	5	8	31	21	23	45	20	11	24	8
Glenn	--	--	1	--	--	--	1	1	--	1
Humboldt	1	2	--	--	--	--	--	--	--	--
Imperial	--	--	2	--	1	--	--	--	1	2
Inyo	--	--	--	--	--	--	--	--	--	--
Kern	1	—	3	18	37	53	10	26	25	9
Kings	2	--	--	1	1	3	10	5	13	2
Lake	--	--	--	--	--	--	--	--	--	--
Lassen	--	--	--	--	--	--	--	--	--	--
Los Angeles	3	1	7	4	3	5	1	6	5	3
Madera	--	--	1	1	8	1	1	--	5	1
Marin	--	--	--	1	--	--	1	--	1	1
Mariposa	--	--	--	--	--	--	--	--	--	--
Mendocino	--	--	2	--	1	--	1	--	--	--
Merced	3	1	3	2	8	7	1	1	2	1
Modoc	1	1	--	--	--	--	--	--	--	--
Mono	--	--	--	--	--	--	--	--	--	--
Monterey	--	1	--	1	--	2	--	--	1	1
Napa	--	2	--	--	1	--	1	--	--	--
Nevada	--	--	--	--	--	--	--	--	--	--
Orange	--	1	--	1	--	--	--	--	--	--
Placer	--	--	1	--	--	--	--	1	1	--
Plumas	--	--	--	--	--	--	--	--	--	--
Riverside	--	2	--	12	2	--	--	--	1	--
Sacramento	6	--	5	1	2	16	2	2	8	11
San Benito	--	--	--	--	--	--	1	--	--	--
San Bernardino	1	1	3	4	1	2	2	1	1	1
San Diego	5	2	5	1	1	1	2	2	--	1
San Francisco	12	7	6	6	2	14	1	3	1	1
San Joaquin	3	8	6	4	6	10	4	7	14	2
San Luis Obispo	--	1	--	1	--	--	1	--	1	--
San Mateo	--	1	2	1	3	5	--	--	--	--
Santa Barbara	2	2	--	--	1	--	--	--	2	1
Santa Clara	2	5	6	3	2	1	2	1	1	4
Santa Cruz	--	--	--	--	1	3	1	--	1	1
Shasta	--	1	--	--	--	1	1	--	--	--
Sierra	--	--	--	--	--	--	--	--	--	--
Siskiyou	--	--	--	--	--	1	--	--	--	--
Solano	2	2	--	1	--	1	--	1	3	2
Sonoma	1	1	3	1	--	--	1	--	1	--
Stanislaus	1	--	3	--	1	2	--	1	8	1
Sutter	--	--	--	1	3	10	1	2	2	2
Tehama	--	--	--	--	--	--	--	--	--	--
Trinity	--	--	--	--	--	--	--	--	--	--
Tulare	1	2	21	2	5	36	21	6	5	4
Tuolumne	--	--	--	--	--	--	--	--	--	--
Ventura	--	--	--	--	--	1	1	1	1	--
Yolo	5	--	3	--	3	13	--	--	20	4
Yuba	--	2	2	--	1	4	2	1	3	2
California (not allocated to any County)	--	--	--	2	1	2	3	--	--	--
Total Cases	66	67	123	98	126	245	101	82	172	78
*Total Deaths	23	34	51	38	30	68	43	48	63	?

Table II—Cases of Human Encephalitis Reported in California, 1935-1944

By Age Groups

Age Groups	*Year* 1935	1936	1937	1938	1939	1940	1941	1942	1943	1944
Under 1 year	1	--	2	4	7	37	3	3	16	4
1-4 years	2	4	15	13	18	35	15	8	28	14
5-9 years	1	1	15	7	22	25	10	8	10	11
10-14 years	5	4	12	10	11	19	11	15	15	7
15-19 years	5	9	11	8	16	18	13	7	9	4
20-24 years	8	6	10	6	6	15	7	9	13	6
25-34 years	11	11	11	11	16	31	20	16	20	9
35-44 years	12	9	14	15	14	15	6	5	13	7
45-54 years	12	14	20	12	5	20	6	7	21	3
55-+ years	9	9	13	10	10	26	9	3	25	9
Adult	--	--	--	2	--	--	--	--	1	2
Not stated	--	--	--	--	1	4	1	1	1	2
Total cases	66	67	123	98	126	245	101	82	172	78

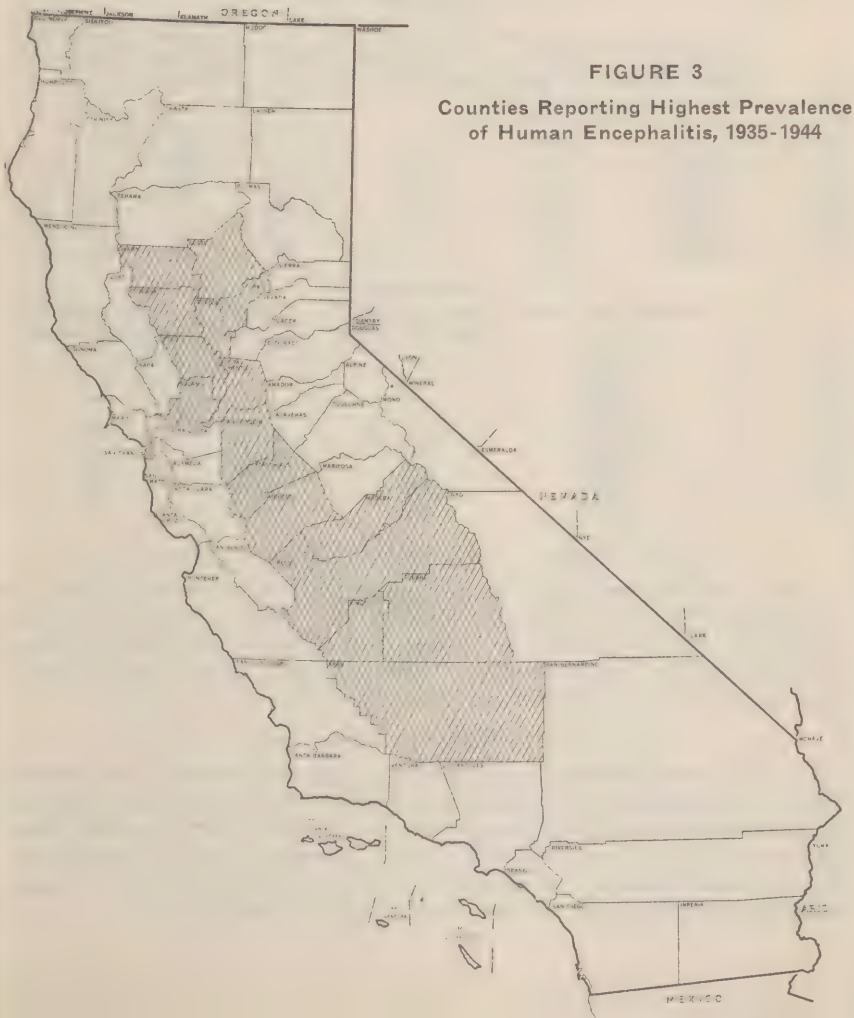

FIGURE 3

Counties Reporting Highest Prevalence of Human Encephalitis, 1935-1944

By Months

Months Reported	*1935*	*1936*	*1937*	*1938*	*1939*	*1940*	*1941*	*1942*	*1943*	*1944*
January	5	7	5	5	4	10	6	3	1	3
February	1	6	1	3	2	6	3	1	4	5
March	--	6	6	7	4	4	5	9	5	8
April	3	1	5	4	5	5	3	6	4	8
May	5	1	4	2	4	11	10	2	2	4
June	2	4	5	6	4	19	4	5	12	5
July	6	8	9	11	18	79	4	5	30	5
August	6	11	24	15	32	43	15	6	45	10
September	9	12	45	19	17	37	22	11	32	5
October	12	8	13	11	21	17	21	14	15	18
November	5	3	2	11	11	8	2	14	10	3
December	12	--	4	4	4	6	6	6	12	4
Total cases	66	67	123	98	126	245	101	82	172	78

Table III—Equine Encephalomyelitis in California and the United States

From Animal Reports, United States Department of Agriculture Bureau of Animal Husbandry

California

Year	*Horses and Mules in Affected Area*	*Horses and Mules Affected*	*Cases per 1000 Horses and Mules*	*Total Deaths*	*Deaths per 100 Affected Animals*	*Months of First Case*	*Months of Last Case*
1935	-------	?	--	---			
1936	-------	few	--	---			
1937	-------	305	--	---	30.		
1938	142,300	491	3.5	---	16.1		
1939	196,500	493	2.5	166	33.		
1940	209,800	732	3.5	242	33.	Feb.	Oct.
1941	78,992	322	4.1	111	34.	June	Oct.
1942	159,910	267	1.7	90	34.	May	Nov.
1943	160,540	760	4.7	206	27.	May	Oct.

United States

Year	*Horses and Mules Affected*	*Cases per 1000 Horses and Mules*	*Total Deaths*	*Deaths per 100 Affected Animals*
1935	23,512	--	--	--
1936	3,929	--	--	--
1937	173,889	--	--	--
1938	184,662	--	--	--
1939	8,008	1.1	2,471	30
1940	16,947	2.6	4,187	25
1941	36,872	6.1	8,210	28
1942	4,939	1.0	1,334	30
1943	4,768	1.1	1,622	30

Eastern Equine and Venezuelan Encephalitis

Other types of encephalitis may be imported to California, and may be also transmitted by our common mosquitoes. They include the eastern equine type found originally in eastern United States but recently found in Texas; and the Venezuelan type. Both of these diseases are similar to those types already in California but their effects are more vicious.

Prevention of Encephalitis

The only possible method for prevention of the spread of the various types of encephalitis now known is through mosquito control, since safe vaccines or chemical prophylactics are not available for humans. Mosquito control for the prevention of these diseases is without precedent. Due to recent discovery of the method of transmission of these diseases, mosquito control for this purpose would be amply justified.

Activities of Mosquito Abatement Agencies in California

Mosquito control and abatement methods used in California are all based on the elimination of larvae breeding. Larvae are the immature forms of the mosquito. The elimination of breeding areas by drainage, filling, or diking is well established, and is generally used where permament control is desired. If breeding areas cannot be eliminated, then breeding must be controlled by the use of larvicides (including oil), fish, or otherwise making the body of water unsuited for the development of mosquitoes. In addition, individuals may protect themselves from mosquito bites by screening doors and windows and using sprays indoors. This attack by individuals on adult mosquitoes has little or no effect on the

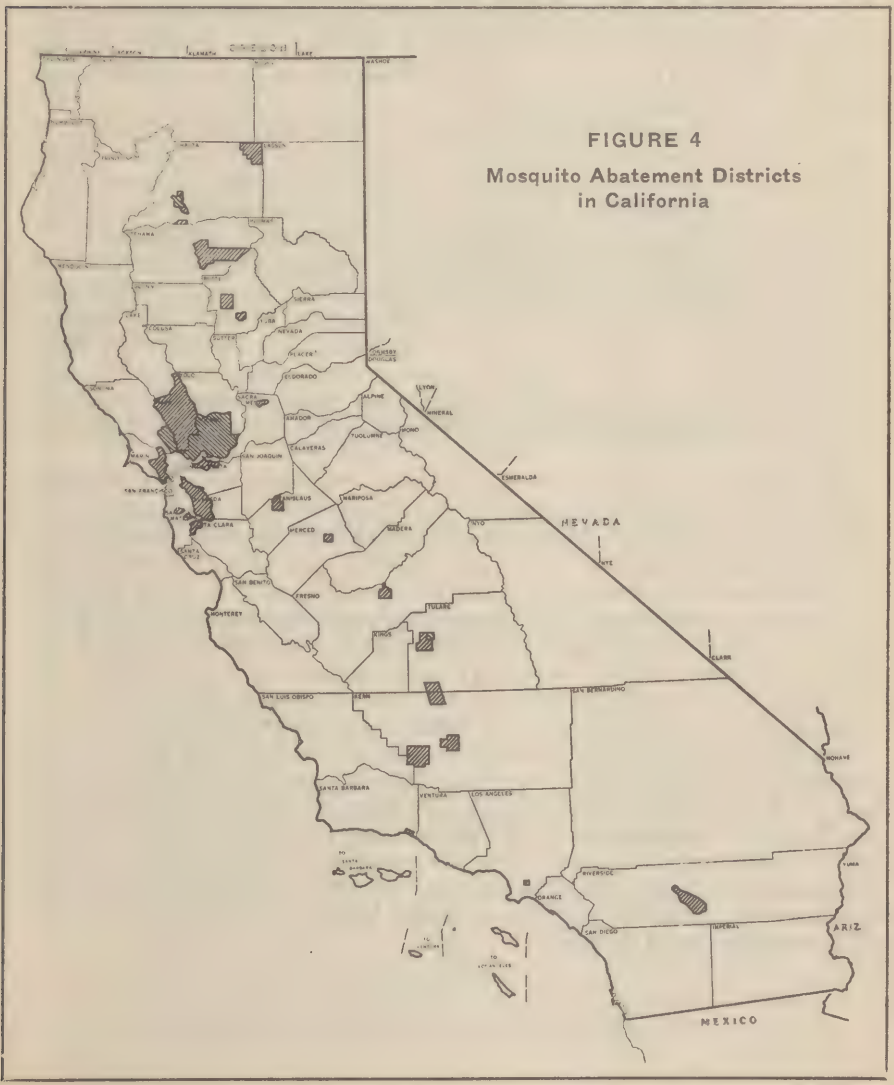

FIGURE 4

Mosquito Abatement Districts in California

mosquito population of the area, but if universally practiced, can reduce mosquito-borne diseases.

There have been no recent changes in these basic methods, except for recent developments by the Army and Navy which have been successfully used for mosquito control. Included are new repellents, the aerosal spray, and D.D.T. (Dichloro-diphenyl-trichlorocthane). These materials are not available now for civilian use. Only D.D.T. appears to have value for mosquito control in large areas. Since D.D.T. has not been available, no investigations have been made to study its adaptability for this purpose in California. It is hoped that D.D.T. will be available in 1945 for experimental use here. Due to its residual toxic effect, when sprayed on buildings, D.D.T. may offer an effective method of adult mosquito control. Its use in this manner will be exceedingly valuable in controlling localized outbreaks of mosquito-borne diseases. Other than this emergency use of D.D.T., no changes in mosquito control methods can be expected before the end of the war.

Twenty-six mosquito abatement districts, two pest abatement districts and at least ten health departments are doing mosquito control work in California. The accompanying map (Figure 4) shows the location of abatement programs in California, and brings out the small areas encompassed compared to the area of the county in which each is situated.

Twelve districts, all in the Sacramento and San Joaquin Valleys, were organized for malaria control, but have also carried on work against pest mosquitoes. One small district in Sacramento County has become inactive because malaria is no longer a problem, and income from taxes is not sufficient to carry on effective control of pest mosquitoes. The map (Figure 2) shows the widespread distribution of the *Anopheles* vector of malaria transmission in the Central Valleys where malaria was formerly endemic.

The effectiveness of the work done in each area varies with the available funds, the interest of the taxpayers and the interests of the trustees and employees. In general, it may be concluded that districts in sections of the State where malaria was formerly endemic have effectively controlled the disease, and those around San Francisco Bay and in other sections having pest mosquito control problems have, in most cases, obtained satisfactory control. In all districts property values have increased, and the health and comfort of the residents have been materially benefitted.

Data on the districts are given in the accompanying table (Table IV) showing area, population, assessed valuation and annual budget.

The problems of mosquito abatement are so complex that they are not subject to simple analysis. For example, costs per square mile, per person, per $100 assessed valuation, or any other basis are not comparable. The density of population, the irrigated area, the cost of water, and the habits of the people are all extremely variable in these districts. The biting and breeding habits of mosquitoes found in each area and even the standards of comfort of the people, play a large part in determining the control program and its cost.

Table IV—Data Relating to Mosquito Control Districts of California

Name	*County*	*Year Organized*	*Area, Square Miles*	*Population*	*Assessed Valuation*	*Tax Rate per $100*	*Budget*	*Cost per sq. Mile*	*Cost per Capita*	*Personnel*
Alameda County	Alameda	1930	320	550,000	$486,800,000 00	$0.01	$47,050 00	$147 00	$0.086	11
Anderson	Shasta	1919	11	1,500	600,000 00	0.15	860 00	78 00	0.57	1
*Carpinteria	Santa Barbara	1937	10	2,500	4,800,000 00	0.03	3,100 00	310 00	1.24	1
Clear Creek	Shasta	1920	32	1,500	1,800,000 00	0.12	1,500 00	47 00	1.00	2
Coachella Valley	Riverside	1928			Activities restricted to gnats only					
Compton Creek	Los Angeles	1929	25	25,000	14,500,000 00	0.0553	7,950 00	318 00	0.32	2
Contra Costa No. 1	Contra Costa	1927	131	52,000	54,000,000 00	0.024	14,000 00	107 00	0.27	3
Cottonwood	Shasta	1919	14	500	700,000 00	0.11	770 00	55 00	1.54	1
Delano	Kern	1944	350	40,000	14,000,000 00	0.06	8,000 00	23 00	0.20	4
Delta	Tulare	1922	27	20,000	10,600,000 00	0.085	10,200 00	380 00	0.51	5
Doctor Morris	Kern	1916	82	75,000	55,900,000 00	0.07	40,000 00	490 00	0.53	10
Durham	Butte	1918	56	1,000	2,600,000 00	0.093	3,000 00	54 00	3.00	1
*East Side	Stanislaus	1939	90	35,000	28,400,000 00	0.10	26,420 00	292 00	0.76	10
Fair Oaks	Sacramento	1918	6	Inactive						
Fresno	Fresno	1942	47	100,000	85,000,000 00	0.06	50,000 00	1,060 00	0.50	8
Los Molinos	Tehama	1917	180	1,700	2,000,000 00	0.15	3,000 00	17 00	1.76	3
Marin County	Marin	1915	181	75,000	45,400,000 00	0.035	16,400 00	91 00	0.22	3
Matadero	Santa Clara	1918	74	32,000	32,000,000 00	0.036	15,000 00	203 00	0.47	4
Merced	Merced	1923	90	16,000	13,000,000 00	0.10	14,000 00	156 00	0.87	3
Napa	Napa	1925	787	42,000	26,100,000 00	0.015	3,900 00	5 00	0.09	3
Oroville	Butte	1916	12	8,500	4,100,000 00	0.103	4,200 00	350 00	0.50	2
Pine Grove	Shasta	1931	210	1,000	4,000,000 00	0.08	3,250 00	15 00	3.25	3
Pulgas	San Mateo	1916	96	40,000	42,100,000 00	0.0232	13,000 00	135 00	0.32	3
Redding	Shasta	1919	4	12,000	4,400,000 00	0.15	8,400 00	2,100 00	0.70	7
Solano County	Solano	1930	911	100,000	65,000,000 00	0.035	16,200 00	18 00	0.15	6
Sonoma	Sonoma	1917	216	8,000	5,100,000 00	0.06	3,000 00	14 00	0.38	1
Three Cities	San Mateo	1915	90	45,000	49,000,000 00	0.029	14,000 00	156 00	0.31	5
Tulare	Tulare	1944	160	20,000	15,300,000 00	0.15	20,230 00	126 00	1.01	5
West Side	Kern	1931	433	25,000	78,000,000 00	0.02	15,600 00	36 00	0.62	6
Totals			4,645	1,339,200	$1,145,200,000 00		$363,030 00			

* Note.—Pest Abatement District.

Alternative Mosquito Control Program

Without detracting in the least from present malaria programs aimed at the control of Anopheline mosquitos and in fact urging improvement in these programs, it is important to pay attention to the recent incrimination of several common species of mosquitoes in the spread of human encephalitis and animal encephalomyelitis in California. Hence, control programs now need to be put on a broader base. So far as the cases of human encephalitis are concerned, the highest rates are reported in 16 counties of the Sacramento and San Joaquin Valleys. A large portion of the program should operate in these counties. It has already been shown that existing control programs on a limited scale are carried on in 10 of the 16 valley counties where human encephalitis is most prevalent. Current expenditures for mosquito control within these 10 counties amount to approximately $281,000 per year. Of this amount, $214,000 are expended by local districts and $67,000 by the United States Public Health Service through its Malaria Control in War Areas Program. These sums do not permit more than an incidental gain in combatting encephalitis. A radical expansion is needed to obtain control of the mosquito vectors of this disease.

State-wide Mosquito Control

State-wide and State-operated mosquito control has been suggested from time to time by various persons, but this is an unnecessary, impracticable, costly, and hence undesirable project. The cost could hardly be less than $5,000,000 per annum, and might reach $10,000,000; under present conditions, the results which could be obtained would not justify such costs. Furthermore, experience indicates that local participation in carrying a large share of the costs of mosquito abatement, and in carrying on the work through local official agencies, has many advantages in practicality and expediency over State-operated abatement, even in emergencies. The proposals made herein therefore contemplate the fullest possible use of the facilities, personnel, and financial resources of local agencies, with supplemental aid from State funds, and with technical and administrative advice and supervision from the State to insure adequate coverage of the problem, and adequate results.

State-Operated Mosquito Control

A State-operated Mosquito Control Program has been considered for areas having the highest reported incidence of mosquito-borne disease. In this area, comprising the great Central Valley of the State, 11 mosquito abatement districts are now carrying on control work. The districts' activities are limited to small areas and outside these small areas no control work is done. A State-operated program might either take over all of the work in the area including that of the existing districts or supplement that work. In either case, friction would almost certainly occur due to parallel organizations, overlapping jurisdiction, and other vexatious problems. The cost to the State would approximate $850,000 per year. This project is not considered advisable.

Proposed Mosquito Control Program

It is concluded that State funds in the order of $500,000 per year are needed to extend present malaria control work and to offer prospects of control of human encephalitis in California. The main elements of the

program comprise (1) an intensified Training Program for Supervisory Personnel, (2) promotion and guidance of the program by a small State administrative force, and (3) an allotment of control funds through subventions to existing or newly formed public agencies. The estimated cost of this program for the first two years is as follows:

	First Year	*Second Year*
Training Program	$12,000 00	$
Administration	50,000 00	50,000 00
Equipment for Mobile Units	8,000 00	1,600 00
Field Personnel	15,000 00	15,000 00
Materials and Supplies	2,000 00	2,000 00
Transportation	2,000 00	2,000 00
Travel Expense	8,000 00	8,000 00
Contingencies	3,000 00	3,000 00
Subventions to Local Agencies	400,000 00	418,400 00
	$500,000 00	$500,000 00

Such a program is proposed and should be undertaken on a continuing basis. The first year the actual control measures would be largely larvicidal and of temporary value. In succeeding years, permanent measures of control such as drainage would increase. Experience in mosquito control in California indicates a gradual reduction in annual cost of control after original equipment is purchased and permanent works are constructed.

With respect to protecting the State against imported mosquito-transmitted disease, Japanese "B" encephalitis is one of the most fearsome. The threat is as yet in a speculative stage. Nevertheless, the plague-like consequences of the disease are such that the opinion of experts is that agencies with facilities for mosquito control should be made ready to roll into action within 24 hours after the virus of the disease is detected in this State. The program outlined above for meeting the prevailing hazards of mosquito-borne disease, supplemented, of course, by local aid, should provide such an action agency which could be thrown quickly into combat against any of the imported and highly dangerous mosquito-borne diseases.

State Promotion of Local Districts

The State has been carrying on through the State Department of Public Health and the University of California limited activities in the promotion of mosquito abatement districts. This work might be expended with technical field staff and mobile demonstration units and would possibly accomplish good results after several years. The cost would be about $75,000 per year. This program is considered less desirable than the program proposed above.

Laws Relating to Mosquito Abatement Districts

Chapter 5 of the Health and Safety Code provides for the organization and management of mosquito abatement districts. The formation of a district can be initiated only by a petition signed by at least 10 per cent of the registered voters, based on the votes cast at the last Gubernatorial election. After suitable hearings before the county board of supervisors.

the district may be formed. Proceedings would be simplified and time saved in emergencies if the county board of supervisors could by resolution initiate the formation of a district. Precedent has been established in the formation of sewer maintenance and county sanitation districts (See Health and Safety Code, Sections 4871 and 4710). Appropriate legislative action should be taken.

The District Investigations Act of 1933 (Act 2119, Deering's General Laws 1941) requires detailed investigation for the information of property owners prior to the formation of certain districts, including mosquito abatement districts. This has delayed formation of several new districts. Hearings must be held before the county board of supervisors in advance of the formation of a new mosquito abatement district and it seems ample opportunity is thus given for protests by property owners. In several other kinds of districts the investigation is not required. A great stimulus to proposed districts would be given if the District Investigations Act were amended so it would no longer apply to mosquito abatement districts.

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